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MANAGEMENT OF INNOVATIVE MILLET PRODUCTS IN THE CONTEXT OF SELECTED CHEMICAL PROPERTIES

In the article it was examined the content of selected elements in certain millet products and the results were compared with the data presented on the labels and data from the literature. Flour and flakes are the most popular products derived from millet. Millet groats is also very often eaten. The flour is made of hulled grains and it often has a maximum ash content, therefore it is related to as whole-meal. It does not contain gluten, so it cannot be used for baking; instead, the best results are achieved by adding it to the flour of other cereal species. Products made from millet soothe the symptoms and effects of many diseases. Standard methods were involved to investigate selected elements in flakes of millet of Batom and Bio Planet company and in flour of millet of Symbio and Bio Futuro company. Despite of some slight differences in the contents of elements determined in the laboratory and those reported in the literature by other authors as well as on the labels, the millet products from all surveyed manufacturers were characterized by abundant contents of macro and micronutrients valuable for human's health. The aim of this study was to examine the contents of selected elements in certain millet products and to compare with the data presented on the labels and data from the literature

Keywords: flour and flakes of millet, selected elements, dry matter and ash, properties

1. INTRODUCTION

At the present time, more and more people suffer from civilization diseases, suffer from food intolerance, and live in the fast lane and stress neglecting a balanced diet, thus do not provide all the necessary nutrients to their organisms. Plants, and more particularly cereals, are the main source of food throughout the world. They occupy the largest cultivation area[3].

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[3] Świetlikowska K., (ed.), 2006. *Surowce spożywcze pochodzenia roślinnego*. Wyd. SGGW, Warszawa, pp. 1-364.
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Millet (*Panicum miliaceum* L) is a valuable crop, yet less popular in our country[4]. Millet plants can be distinguished by the fact that they do not contain gluten, are easy to digest, and have large amounts of valuable and readily digestible elements in their composition[5]. Products made from millet soothe the symptoms and effects of many diseases; they are also worth consuming in the prevention of civilization diseases and cancers of different organs that occur more often nowadays[6].

Flour and flakes are the most popular products derived from millet. Millet groat is also very often eaten. The flour is made from hulled grains and it often has a maximum ash content, therefore it is related to as whole-meal. It does not contain gluten, so it cannot be used for baking; instead, the best results are achieved by adding it to the flour of other cereal species. In addition, it is used as a thickener for soups, pastes, savory dishes, and desserts. Bread made of millet flour shows greater volume, as well as its other characteristics desired by consumers such as, for example, better color, odor, flavor, and texture, are improved[7].

The aim of this study was to examine the contents of selected elements in certain millet products and to compare with the data presented on the labels and data from the literature.

2. MATERIALS AND METHODS

The tested millet products (flour and flakes) were subject to determinations of water and dry matter content (absolute dry matter) in the air-dry samples, which consisted in drying the aliquot of particular material at 100-105 °C to a constant weight and subsequent calculating the amount of water from the mass difference. Clean ash in tested products was determined in a muffle furnace, where the temperature was graded from 250-300 °C, through 450 °C and 550 °C. Also wet mineralization of tested products was conducted: in concentrated H_2SO_4 with H_2O_2 addition to determine the total N – by means of Kjeldahl method, P – applying vanadium-molybdate colorimetric method at a wavelength of 470 nm, K, Ca, Mg, Na, Mn, and Zn by atomic absorption spectrometry (AAS), as well as Fe using colorimetric method with ammonium thiocyanate. The intensity of the resulting color was measured on a colorimeter in 1 cm^3 capacity cuvettes at a wavelength of

[4] Czerwińska D., 2009. *Charakterystyka żywieniowa kasz Cz. II. Wartość odżywcza i zdrowotna kaszy jaglanej*. W: Przegl. Zbożowo-Młyn., R. 53 nr 11, 12-13.
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466 nm. Prior to determination, the total amount of iron was oxidized to trivalent using 3% H_2O_2.

All laboratory analyses of tested samples were performed in triplicates. Products were purchased from different producers: millet flakes from Batom and Bio Planet, while millet flour from Symbio and Bio Futuro.

3. RESULTS AND DISCUSSION

3.1. Ash and water contents in dry matter of millet products

Tables 1 and 2 present results of laboratory determinations related to dry matter, water, and ash contents in tested millet products. Achieved values were compared with literature data.

Table 1. Dry matter, water, and ash contents in millet flakes from two producers

Product	Component	Results	Mean	Literature
Millet flakes from Batom	Dry matter [g/kg]	0.89	0.90	0.87 [1)]
		0.90		
		0.90		
	Water [g/kg]	0.11	0.10	0.13 [2)]
		0.10		
		0.10		
	Ash [g/kg]	0.01	0.01	0.03 [3)]
		0.01		
		0.01		
Millet flakes from Bio Planet	Dry matter [g/kg]	0.91	0.91	0.87 [4)]
		0.91		
		0.92		
	Water [g/kg]	0.09	0.09	0.13 [5)]
		0.09		
		0.08		
	Ash [g/kg]	0.02	0.02	0.03 [6)]
		0.02		
		0.02		

1) through 6) Rudziński[8].

Analysis of the dry matter in organic millet flakes traded by two producers (Batom and Bio Planet) revealed that results differed only by 0.01 g/kg (Table 1). In another product – organic flour by Symbio – dry matter content was lower and amounted to 0.85 g/kg, while in the other flour, which is a natural product, it was 0.86 g/kg (Table 2). Rudziński[8] reported that the content of dry matter in millet grain oscillated around the average of 0.87 g/kg. Water complements dry matter in products. According to Rudziński[9], flakes should contain 0.13 g/kg of water. Results obtained in this study are similar and are at a level of 0.10 g/kg of the product from Batom and 0.09 g/kg of the product from Bio Planet (Ta-

[8] Rudziński R., 2011. *Zasady przechowywania i magazynowania towarów pochodzenia rolniczego*. W: Zesz. Nauk. Uni. Przyrod.-Human. w Siedlcach, nr 88, 113-115.

[9] Ibid.

ble 1). And also according to Rudziński[10], water in millet grain, like in flakes, should be at the level of about 0.13 g/kg. The results achieved by authors of the present paper were 0.15 g/kg for organic flour and 0.14 g/kg for natural product (Table 2).

Table 2. Dry matter, water, and ash contents in millet flour from two producers

Product	Component	Results	Mean	Literature
Millet flour from Symbio	Dry matter [g/kg]	0.87	0.85	0.87 1)
		0.79		
		0.89		
	Water [g/kg]	0.13	0.15	0.13 2)
		0.21		
		0.11		
	Ash [g/kg]	0.02	0.01	0.03 3)
		0.01		
		0.01		
Millet flour from Bio Futuro	Dry matter [g/kg]	0.90	0.86	0.87 4)
		0.78		
		0.90		
	Water [g/kg]	0.10	0.14	0.13 5)
		0.22		
		0.10		
	Ash [g/kg]	0.01	0.01	0.03 6)
		0.01		
		0.01		

1) through 6) Rudziński[11].

Ash was present in tested products at the level of 0.01 g/kg (Batom) and 0.02 g/kg (Bio Planet), while data reported by Rudziński[11] reveal mean ash content at about 0.03 g/kg (Table 1); the millet flour from both producers contained 3-fold less ash (Table 2).

3.2. Macroelements in millet products

Tables 3-4 show the nitrogen, phosphorus, and potassium contents in the millet products. The nitrogen quantity recalculated from the protein amount indicated on the label of millet flakes was 16 g/kg, while results obtained in the laboratory was 16.38 g/kg in the product from Batom and 19.09 g/kg from another producer (Table 3). Similarly in the case of flour: the label indicated 14.56 g/kg, whereas results achieved in the laboratory were significantly higher (Table 4). The Symbio flour contained nitrogen at the amount of 17.27 g/kg, while for the other manufacturer (Bio Futuro), it was up to 19.04 g/kg (Table 4).

[10] Ibid.

[11] Ibid.

Table 3. Nitrogen, phosphorus, and potassium in millet flakes from two producers

Product	Element	Results	Mean	Literature
Millet flakes from Batom	N [g/kg]	16.38	16.38	16.00 [1)]
		16.24		
		16.52		
	P [g/kg]	1.80	1.75	2.40 [2)]
		1.65		
		1.80		
	K [g/kg]	1.76	1.75	1.95 [3)]
		1.68		
		1.81		
Millet flakes from Bio Planet	N [g/kg]	19.18	19.09	16.00 [4)]
		19.04		
		19.04		
	P [g/kg]	3.30	3.13	2.40 [5)]
		3.00		
		3.10		
	K [g/kg]	2.51	2.36	1.95 [6)]
		1.98		
		2.59		

1) and 4) Information on the label, 2) and 5) Czerwińska[12], 3) and 6) Czerwińska[12].

Table 4. Nitrogen, phosphorus, and potassium in millet flour from two producers

Product	Element	Results	Mean	Literature
Millet flour from Symbio	N [g/kg]	17.36	17.27	14.56 [1)]
		17.36		
		17.08		
	P [g/kg]	2.9	2.83	2.40 [2)]
		2.8		
		2.8		
	K [g/kg]	1.88	1.85	1.95 [3)]
		1.82		
		1.85		
Millet flour from Bio Futuro	N [g/kg]	18.76	19.04	14.56 [4)]
		19.04		
		19.32		
	P [g/kg]	2.35	2.30	2.40 [5)]
		2.35		
		2.2		
	K [g/kg]	1.52	1.56	1.95 [6)]
		1.56		
		1.61		

1) and 4) Information on the label, 2) and 5) Czerwińska[12], 3) and 6) Czerwińska[12].

Like in the case of nitrogen, phosphorus proportions were also diverse in millet flakes. The test material from Batom contained phosphorus in an amount of 1.75 g/kg, while

from Bio Planet the value was almost twice as high (3.13 g/kg). Czerwińska[12] in the study upon the value of millet groats reported 2.4 g/kg of phosphorus. When comparing the phosphorus content in millet flour, some differences are prominent. Czerwińska[13] determined the phosphorus content in millet groats for 2.40 g/kg, while 2.83 g/kg in millet flour. The product purchased in Futuro Bio contained phosphorus at the level of 2.30 g/kg. This value was similar to results reported by other authors (Tables 3 and 4)[14].

Potassium content in the product from Batom was 1.75 g/kg and it was slightly lower than the result obtained by Czerwińska[15] in the grain. However, flakes purchased from the other producer contained 2.36 g/kg K, which was even higher than results found by Czerwińska[16] (Table 3). Results related to potassium content in flour and obtained in the laboratory were similar to those reported by cited author Czerwińska[17]. Millet flour manufactured by Symbio contained 1.85 g/kg of potassium, while according to Czerwińska[18], the millet grains contained 1.95 g/kg of potassium in dry matter. A significant difference was observed when comparing percentage of potassium present in the flour from Futuro Bio and results achieved by Czerwińska[19] – as much of 0.39 g/kg (Table 4).

Tables 5 and 6 show the contents of calcium, magnesium, and sodium present in the millet products. The amount of calcium in millet flakes from Batom was 2.5 times lower than the information on the labels of products (Table 5). Even greater difference was observed between the calcium content indicated on the packaging and in tested flakes from the other manufacturer. On the other hand, no such differences were observed in the flour (Table 6). The calcium contents in the flour from Symbio and grain examined by another author were similar (Table 6). In laboratory, this element quantity was determined for 0.05 g/kg, while Czerwińska[20] found that the amount of calcium was 0.08 g/kg. A smaller difference was recorded when comparing this value to the calcium content in the millet flour from Bio Futuro (0.10 g/kg).

Table 5. Contents of Ca, Mg, and Na in millet flakes from two producers

Product	Element	Results	Mean	Literature
Millet flakes from Batom	Ca [g/kg]	0.15	0.10	0.25 [1)]
		0.1		
		0.06		
	Mg [g/kg]	0.84	0.84	1.14 [2)]
		0.76		
		0.91		
	Na [g/kg]	0.04	0.03	- [3)]
		0.02		
		0.03		

[12] Czerwińska D., 2009. *Charakterystyka żywieniowa*... Op. Cit.

[13] Ibid.

[14] Czerwińska D., 2009. *Charakterystyka żywieniowa*... Op. Cit.
Czerwińska D., 2010. *Wartość odżywcza*... Op. Cit.

[15] Czerwińska D., 2010. *Wartość odżywcza*... Op. Cit.

[16] Ibid.

[17] Ibid.

[18] Ibid.

[19] Ibid.

[20] Ibid.

Product	Element	Results	Mean	Literature
Millet flakes from Bio Planet	Ca [g/kg]	0.06	0.09	0.25 [4)]
		0.15		
		0.06		
	Mg [g/kg]	1.32	1.43	1.14 [5)]
		1.42		
		1.56		
	Na [g/kg]	0.03	0.03	- [6)]
		0.04		
		0.02		

1) and 4) Information on the label, 2) and 5) Czerwińska[14], 3) and 6) Czerwińska[14].

Table 6. Contents of Ca, Mg, and Na in millet flour from two producers

Product	Element	Results	Mean	Literature
Millet flour from Symbio	Ca [g/kg]	0.05	0.05	0.08 [1)]
		0.05		
		0.05		
	Mg [g/kg]	1.38	1.37	0.95 [2)]
		1.45		
		1.27		
	Na [g/kg]	0.05	0.04	- [3)]
		0.03		
		0.03		
Millet flour from Bio Futuro	Ca [g/kg]	0.07	0.10	0.08 [4)]
		0.14		
		0.08		
	Mg [g/kg]	1.15	1.13	0.95 [5)]
		1.06		
		1.18		
	Na [g/kg]	0.03	0.05	- [6)]
		0.06		
		0.05		

1), 2), 4), 5) Czerwińska[14], 3) and 6) Unavailable data

Results related to magnesium appeared to be different. Depending on a manufacturer, various results were achieved (Table 5). This element determined in flakes from Batom occurred in an amount significantly less than in the study performed by Czerwińska[21] (1.14 mg/kg of magnesium in millet grains), whereas flakes from Bio Planet contained 1.43 g/kg of magnesium. This was the highest magnesium content achieved in all tested products. Millet flour contained less magnesium than flakes (Table 6). According to Czerwińska[22], there is about 0.95 g/kg of the element. However, in this study it was found that magnesium appeared in an amount of 1.37 g/kg in product from Symbio and 1.13 g/kg from Bio Futuro (Table 6). Comparison of the sodium content in tested products

[21] Ibid.

[22] Ibid.

revealed that more of the element was present in the millet flour rather than in flakes (Tables 5 and 6).

3.3. Microelements in millet products

Tables 7 and 8 show the contents of selected trace elements in tested millet products. Manganese in flakes from Batom occurred at the level of 7.00 mg/kg (Table 7), while the flour from Symbio and Bio Futuro was present at lower amounts (6.67 mg/kg and 5.33 mg/kg) (Table 8). Czerwińska[23] reported that millet grain can contain up to 16.00 mg/kg of manganese. A similar manganese content as on the label was found in flakes purchased from Bio Planet. Those differences may resulted from technological processing.

Table 7. Microelement contents in millet flakes from two producers

Product	Element	Results	Mean	Literature
Millet flakes from Batom	Mn [mg/kg]	7.00	7.00	16.00 1)
		7.00		
		7.00		
	Zn [mg/kg]	21.20	19.57	17.00 2)
		18.20		
		19.30		
	Fe [mg/kg]	0.01	0.02	0.90 3)
		0.02		
		0.02		
Millet flakes from Bio Planet	Mn [mg/kg]	11.00	11.00	16.00 4)
		11.00		
		11.00		
	Zn [mg/kg]	28.50	27.73	17.00 5)
		26.40		
		28.30		
	Fe [mg/kg]	0.04	0.04	0.90 6)
		0.03		
		0.05		

1), 2), 5), 6) Czerwińska[23], 3), 4), 7), 8) Information on the label

Just like in the case of flakes (Table 7), zinc proportion in millet flour (Table 8) was higher than that determined by Czerwińska[24] in the grain. The iron content in flour was at a similar level as in the study carried out by Czerwińska[24] in this product (Table 8). Greater differences were observed for flakes (Table 7). The zinc content in all tested millet products was higher than that reported by Czerwińska[25] for grains.

[23] Ibid.

[24] Ibid.

[25] Ibid.

Table 8. Microelement contents in millet flour from two producers

Product	Element	Results	Mean	Literature
Millet flour from Symbio	Mn [mg/kg]	7.00	6.67	16.00 [1)]
		7.00		
		6.00		
	Zn [mg/kg]	28.20	29.10	17.00 [2)]
		30.20		
		28.90		
	Fe [mg/kg]	0.05	0.06	0.07 [3)]
		0.06		
		0.08		
Millet flour from Bio Futuro	Mn [mg/kg]	5.00	5.33	16.00 [4)]
		6.00		
		5.00		
	Zn [mg/kg]	23.90	23.57	17.00 [5)]
		22.30		
		24.50		
	Fe [mg/kg]	0.05	0.10	0.07 [6)]
		0.18		
		0.06		

1) through 6) Czerwińska[25].

4. CONCLUSIONS

1. Dry matter, water, and ash contents in all tested products were close to the literature data. An exception was the millet flour, in which the ash content was three times lower than that indicated in literature.
2. The contents of macronutrients differed from data provided on the label or in literature. Flakes of two manufacturers (Batom and Bio Planet) contained less P and K than described in literature, while less nitrogen as compared to the content shown on the labels. The flour from Symbio contained more N and P, whereas less K than those found by other researchers and information on the packaging.
3. Contents of other macroelements (Mg, Ca, Na) and microelements (Mn, Zn, Fe) in flakes from Batom and Bio Planet also differed from the literature data and information on the labels.
4. It should be noted that despite of some slight differences in the contents of elements determined in the laboratory and those reported in the literature by other authors as well as on the labels, the millet products from all surveyed manufacturers were characterized by abundant contents of macro and micronutrients valuable for human's health.

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ZARZĄDZANIE INNOWACYJNYMI PRODUKTAMI Z PROSA W KONTEKŚCIE WYBRANYCH WŁAŚCIWOŚCI CHEMICZNYCH

Zbadano zawartości wybranych pierwiastków w niektórych produktach z prosa i porównano te zawartości z danymi na etykietach oraz danymi z literatury. Mąka i płatki to najpopularniejsze produkty pozyskiwane z prosa. Bardzo często spożywana jest również kasza, zwana jaglaną. Mąka powstaje z obłuszczonego ziarna, często ma ona najwyższą zawartość popiołu, od czego zwana jest razową. Produkty z prosa łagodzą objawy i skutki wielu schorzeń. Badania laboratoryjne prowadzono standardowymi metodami w płatkach jaglanych z firm: Batom i Bio Planet oraz w mące jaglanej firm: Symbio i Bio Futuro. Mimo pewnych, nieznacznych różnic w zawartościach badanych pierwiastków stwierdzonych w laboratorium i podanych w literaturze przez innych autorów oraz na etykietach, produkty z prosa wszystkich badanych firm odznaczały się bogatą zawartością cennych dla zdrowia makro- i mikroelementów. Celem niniejszych badań było określenie zawartości wybranych pierwiastków w niektórych produktach z prosa I porównanie tych zawartości z danymi z literatury I na etykietach badanych produktów. Chociaż zanotowano pewne różnice w stężeniach badanych pierwiastków oznaczonych na etykietach i laboratoryjne, to jednak produkty z prosa charakteryzowały się zbliżonymi zawartościami składników pokarmowych, ważnych z punktu widzenia zdrowia człowieka, prezentowanych w niniejszych badaniach i przez innych autorów. Uwzględnienie odżywczych produktów z prosa w diecie człowieka jest jednym z innowacyjnych zmian w trendach żywnościowych.

Słowa kluczowe: mąka i płatki z prosa, wybrane makro- i mikroelementy, sucha masa i popiół, właściwości.

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